NATIONAL ESTIMATES OF INDIRECT FIRE COSTS

NBTCLAC4

Excerpts from Indirect Costs of Residential Fires, FA-6, April 1980

federal emergency management agency
U.S. fire administration

The principal aim of the research was to develop estimates of annual indirect costs resulting from residential fires in the United States. This chapter presents these estimates. Section A describes the types of fire costs covered in the research; Section B presents several different conceptual definitions of indirect costs which were used; national aggregate cost estimates are then presented in Section C, together with a brief description of the methodology used for calculating them.

Several caveats must be kept in mind when considering the figures discussed in this report. The estimated costs may include some downward bias due to the possibility that it may be particularly difficult to obtain interviews with members of households which experience the most serious fires. While extensive procedures were incorporated into the data collection process to minimize the extent of this problem, it is unlikely that all bias resulting from this situation has been eliminated. In addition, it should be noted that the interviews were conducted approximately four months after the fires experienced by the households and it is therefore possible that not all costs had been incurred, particularly in the case of households with members requiring extensive medical treatment. This too could result in an understatement of total costs. Still another possible reason for inaccuracy in the estimates is that, in the cases where costs were covered by insurance, households may not have been fully aware of the actual costs incurred.

For all these reasons, it is possible that the figures reported here may somewhat underestimate actual indirect costs associated with residential fires, and this potential for understatement may be greatest with regard to medical costs.

A. Definition of Indirect Versus Direct Losses

The objective of this study was to develop a national estimate of indirect residential fire costs which, when combined with an estimate of direct losses based on fire department fire reports, would yield an accurate overall picture of total losses as the result of reported residential fires in the United States. Since fire department reports typically include in their dollar loss estimates only damage directly done to buildings and contents, the subject of the present study, indirect fire costs, was operationally defined to include all costs other than the value of damage directly done to structures and their contents. In particular, the following categories of indirect costs were considered: medical costs, temporary shelter costs, costs of missed work, extra meal costs, funeral costs, demolition costs, cost of legal fees, and other similar, miscellaneous cost items which are not included in those explicit categories.

Three categories of indirect fire costs which had to be omitted from the cost calculations presented in this chapter should be noted. First, and perhaps most important, no attempt has been made to place a monetary value on the pain, both physical and psychological, experienced by fire victims and their friends and relatives as a result of the fires. Fires often have devastating nonmonetary impacts because of such factors as deaths, injuries, dislocation, loss of cherished and irreplaceable possessions, and trauma. Indeed, in many cases such costs may be greater in magnitude than those to which monetary values can be assigned. Some effort was made in the present study to assess the overall dimensions of these nonmonetary costs, and the results of this work are presented in Chapter III, which begins on page 12. However, such costs are not included in the monetary loss estimates presented in this chapter simply because it is not possible to assign monetary values to them.[7]

A second indirect cost which was not included in the scope of the current research is medical and related costs for firefighters injured while fighting residential fires. Such costs were not included in the present study because they cannot be estimated on the basis of information obtained from interviews of households experiencing fires.[8]

Finally, a third cost which is not included in this analysis is demolition costs for multi-family dwelling units which had to be torn down as a result of a fire. This cost item, like that of firefighter medical costs, was excluded from the research because it could not be obtained from the household interviews which form the basis of the present study.

B. Alternative Conceptual Definitions of Indirect Costs

Two different ways of conceptualizing indirect costs have been used in the analysis. One of these includes total aggregate costs to society regardless of who bears those costs. This definition of costs (designated as total costs) is important in applications where the objective is to gain as complete a picture as possible of the total costs of fires. For instance, it is this first definition which is appropriate for a cost-benefit analysis of the economic efficiency of further government investment in the development of fire prevention and control technologies.

The second definition of indirect costs that is used here includes only those that are borne by the households experiencing the fires. Under this second definition, losses covered by insurance or borne by public agencies are not included. Similarly, the value of lost worktime for which employers continued to pay wages and the value of temporary shelter

---

[7] In many cases, these nonmonetary costs lead fire victims to incur monetary costs by obtaining professional help, and when this happens the resulting monetary costs are included in the cost estimates presented here.

[8] There have been other studies of firefighter injuries and fatalities. See, for instance, *Fire Fighter Mortality Report*, prepared for the Center for Fire Research, Institute for Applied Technology, National Bureau of Standards, by the International Association of Fire Fighters.

provided by friends or relatives are excluded. This second conceptualization of costs (designated as out-of-pocket costs) is important in contexts where the aim is to measure, at a more personal level, the unexpected burden which fires impose on the families to whom they occur. An example of such a context, for instance, would be policy decisions regarding public assistance programs designed to help such families cope with these costs.

Since both of the above definitions of indirect costs are of potential importance to policymakers, estimates of each of them have been developed in the current research and are discussed in Section C of this Chapter.

C. National Estimates of Indirect Fire Costs of Residential Fires

The interviews on which the current research is based were obtained from a stratified random sample of 883 households which had experienced fires approximately four months prior to their being interviewed. This sample was divided into three groups in order to maximize the efficiency of the resulting cost estimates. In deriving national indirect fire cost estimates, therefore, the first step was to compute the average indirect cost per fire in the sample for each stratum. Next, total fire costs per stratum were estimated by multiplying these average costs for each stratum by independently supplied estimates of the total number of residential fires in each stratum occurring in the United States in 1976.[9] This was done for the three strata for each of four estimates of the number of reported residential fires occurring nationally in 1976.[10] The final step was to add the totals for each of the three strata in each of the four estimates to obtain four national estimates of the amount of indirect costs caused by reported residential fires annually in the United States.

TABLE II.1

National Estimates of Indirect Costs for Residential Fires for Different Assumptions Concerning the Number of Fires

	Cost in $ millions	
Estimated Number of Residential Fires	Estimated Total Costs	Estimated Out-of-Pocket Costs
Low estimate of total residential fires in country 502,000	$220.3	$105.0
First middle-range estimate of total residential fires in country 665,400	292.1	139.2
Second middle-range estimate of total residential fires in country 700,000	307.3	146.4
High estimate of total residential fires in country 735,000	322.6	153.8

[9] The survey data used in estimating average dollar losses were gathered in the first half of 1977. Hence, the estimates which have been developed should be considered as estimates for 1976 stated in early 1977 dollars.

[10] The four estimates were derived as follows. The low estimate is based on incidence rates for the States of Ohio and California combined, obtained from the National Fire Data Center data files. These incidence rates were applied to 1976 Census estimates of the United States population. This generated estimates of 25,800 fires causing injury or death (stratum I); 88,400 fires causing no injury or death, but causing property damage in excess of $1,000 (stratum II); and 387,800 fires not causing injury or death, and causing property damage of $1,000 or less (stratum III); a total of 502,000. The second estimate used in the analysis, 665,400 was obtained from the most current figures from the NFPA (excluding hotel and motel fires) as presented in Derry (1977). These were allocated among the three strata according to the proportions derived in the first estimate. The high estimate, 735,000 fires, was obtained from recent studies by the National Fire Data Center that indicate that a total of 2,600,000 fires occur annually, and that 28.3 percent of these are residential (memorandum from Paul Gunther, December 22, 1977). Again, the number of residential fires was allocated among the three strata according to the proportions derived in the first estimate. Finally, a compromise figure of 700,000 residential fires was selected between the last two. These were also allocated among the three strata according to the proportions used in the other estimates. Thus, there is a series of four estimates, ranging from 502,000 to 735,000 residential fires per year.

These calculations were performed for each of the two indirect cost definitions discussed previously in Section B, and the results are presented in Table II.1. As shown in the table, the total annual indirect costs associated with residential fires in the United States range from a low estimate of $220.3 million to a high of $322.6 million, depending on the estimated number of residential fires. However, a substantial share of these total costs was borne by persons or organizations other than the households experiencing the fire. Indeed, over half of these costs were distributed outside the households, and the out-of-pocket costs to the households ranged from $105.0 million to $153.8 million.

Table II.2 also presents cost estimates by type of cost. It is clear that the most important component of indirect costs is temporary shelter, which amounts to almost 45 percent of the total. In addition, it is apparent that the top three components listed in Table II.2 (temporary shelter costs, medical care costs, and costs due to missed work) constitute over three-fourths of the total estimated indirect costs and of estimated out-of-pocket costs. This suggests that public policy aimed at alleviating residential fire costs might most appropriately focus on these three components.

In assessing the loss estimates presented here, attention should be given to possible errors in the estimates due to sampling variation. Standard errors of the loss estimates due to sampling have been estimated on the basis of sample characteristics, and the results of these calculations are shown in

TABLE II.2

Summary Of National Indirect Cost Estimates (In $ millions)

Cost Component	502,000 Fires		665,400 Fires		700,000 Fires		735,000 Fires		Percent	
	Total Cost	Out-of-Pocket Cost	Total Cost	Out-of-Pocket Cost	Total Cost	Out-of-Pocket Cost	Total Cost	Out-of-Pocket Cost	Total Cost	Out-of-Pocket Cost
Temorary Shelter	$98.7	$22.6	$130.8	$29.9	$137.7	$31.5	$144.5	$33.1	44.8%	21.5%
Medical Care [1]	53.7	39.7	71.3	52.6	75.0	55.3	78.7	58.1	24.4	37.8
Missed Work	26.2	17.8	34.8	23.5	36.5	24.7	38.4	26.0	11.9	16.9
Funeral	8.1	2.6	10.8	3.5	11.4	3.7	11.9	3.8	3.7	2.5
Extra Food	9.7	6.6	12.9	8.8	13.5	9.2	14.2	9.7	4.4	6.3
Emotional Counseling	4.6	0.8	6.1	1.1	6.5	1.2	6.8	1.2	2.1	0.8
Demolition	4.0	2.4	5.3	3.2	5.5	3.4	5.8	3.5	1.8	2.3
Legal Fees	2.9	2.0	3.8	2.7	4.0	2.8	4.2	2.9	1.3	1.9
Transportation	1.8	1.5	2.3	1.9	2.5	2.0	2.6	2.2	0.8	1.4
Child Care	0.7	0.4	0.9	0.6	0.9	0.6	1.0	0.7	0.3	0.4
Other	9.9	8.6	13.1	11.4	13.8	12.0	14.5	12.6	4.5	8.2
TOTALS	$220.3	$105.0	$292.1	$139.2	$307.3	$146.4	$322.6	$153.8	100.0%	100.0%

[1] It is possible that medical care costs may be somewhat understated.

Table II.3.[11] As indicated in this table, for instance, the standard error associated with the $322.6 million estimate of total indirect costs is approximately $40 million. This implies that one can be 95 percent certain that—at least with regard to sampling error—the true value of such costs is plus-or-minus $90.4 million, or approximately 28 percent of the estimated values shown in the table.[12] Similar statements can be made with regard to the estimates for losses borne by households.

The relatively high standard errors shown in Table II.3 imply that the loss estimates developed in the present study must be used with some caution. While they are suggestive of the overall order of magnitude of indirect fire losses due to residential fires in the United States, they may well be subject to considerable error. This relatively large potential error reflects the present study's being developed only as a rough, first-cut attempt to measure indirect fire losses. The relatively limited resources allowed less than 900 interviews, a relatively small sample for a national study. Furthermore, the precision of the estimates was further reduced by the need to cluster the sample in 10 different sites throughout the country.

TABLE II.3

Standard Errors of Estimates

Base Number of Residential Fires	Standard Error of Total Cost Estimate ($ millions)	Standard Error of Out-of-Pocket Cost Estimate ($ millions)
502,000	$27	$12
665,400	36	16
700,000	38	17
735,000	40	18

For those who are technically oriented:

[11] It should be noted that the standard error estimates were adjusted to partially exclude the effects on them of an observation which appears to be an extreme outlier in the sample.

[12] The standard error estimates in Table II.2 have been estimated with nine degrees of freedom. Therefore, a 95 percent confidence interval extends approximately 2.26 standard deviations from the estimated loss value.

THE NATURE OF INDIRECT LOSSES

TABLE III.14

Percent Distribution of Indirect Fire Costs by Direct Property Loss

Total Cost And Out-Of-Pocket Cost [1]

Direct Property Loss ($)	Percent of Fires [2] Causing Indirect Costs of: ($)									
	0	$1 to $100	$101 to $200	$201 to $500	$501 to $750	$751 to $1,000	$1,001 to $1,500	$1,501 to $6,500	$6,501 and over	Total
0	97.0% (97.0%)	1.0% (1.0%)	0.0% (1.0%)	1.0% (0.0%)	1.0% (1.0%)	0.0% (0.0%)	0.0% (0.0%)	0.0% (0.0%)	0.0% (0.0%)	100.0% (100.0%)
1 to 100	84.1 (87.7)	6.6 (6.6)	1.9 (0.0)	2.8 (3.8)	0.9 (1.9)	0.9 (0.0)	1.9 (0.0)	0.9 (0.0)	0.0 (0.0)	100.0 (100.0)
101 to 500	71.7 (78.7)	9.4 (11.8)	6.3 (3.1)	4.8 (2.4)	3.1 (1.6)	0.0 (0.0)	1.6 (1.6)	3.1 (0.8)	0.0 (0.0)	100.0 (100.0)
501 to 1,000	60.3 (73.5)	11.8 (10.3)	4.4 (8.8)	5.9 (3.0)	4.4 (2.9)	2.9 (1.5)	1.5 (0.0)	5.9 (0.0)	2.9 (0.0)	100.0 (100.0)
1,001 to 2,500	51.4 (69.7)	13.4 (11.3)	5.6 (3.5)	9.2 (9.2)	2.1 (0.7)	3.5 (2.8)	5.6 (1.4)	8.5 (0.7)	0.7 (0.7)	100.0 (100.0)
2,501 to 5,000	31.2 (49.6)	8.8 (13.6)	7.2 (11.2)	13.6 (12.8)	6.4 (3.2)	4.8 (0.8)	4.8 (3.2)	20.0 (4.8)	3.2 (0.8)	100.0 (100.0)
5,001 to 7,500	18.7 (37.5)	10.4 (12.5)	6.2 (6.2)	8.3 (16.7)	14.6 (8.3)	4.2 (2.1)	12.5 (6.3)	22.9 (8.3)	2.1 (2.1)	100.0 (100.0)
7,501 to 10,000	15.9 (31.8)	9.1 (6.8)	6.8 (13.6)	15.9 (18.2)	0.0 (4.6)	6.8 (6.8)	13.6 (6.8)	29.6 (11.4)	2.3 (0.0)	100.0 (100.0)
10,001 and over	11.3 (31.5)	4.8 (8.1)	2.4 (5.6)	12.9 (12.9)	4.0 (9.7)	6.5 (6.5)	7.3 (4.8)	43.5 (16.9)	7.3 (4.0)	100.0 (100.0)
Totals	51.9 (64.6)	8.3 (9.3)	4.4 (5.2)	8.1 (8.0)	3.6 (3.4)	3.1 (2.0)	4.5 (2.3)	14.1 (4.3)	2.0 (0.9)	100.0 (100.0)

[1] Out-of-Pocket Costs are in parentheses.
[2] Includes all fires including those with no indirect costs.

TECHNIQUES FOR LOCAL ESTIMATION OF INDIRECT RESIDENTIAL FIRE COSTS

IV. TECHNIQUES FOR LOCAL ESTIMATION OF RESIDENTIAL INDIRECT FIRE COSTS

The previous chapters have discussed national estimates of total indirect costs of residential fires and the various components of indirect costs based on data from a survey of 883 households across the country. This chapter discusses methods by which fire officials can estimate the magnitude of the indirect costs from residential fires in their own service areas.

There are several approaches to this problem. The simplest makes use of the average value of total indirect costs per fire. Using estimates from this study, and the number of reported residential fires occurring in the local area during the specified period, an estimate of local indirect costs incurred during that period can be obtained. A slightly more complex version of this approach is to consider averages for different categories of residential fires, as was done in making the national estimates, and then estimating indirect costs for each category. When added, these estimates represent the total amount of indirect costs occurring in the area.

A third approach makes use of the observed relationship between the indirect costs caused by a residential fire and the direct property losses which that fire caused. Residential fires can be grouped into categories of direct property loss and indirect costs estimated for each category. Again, the indirect costs for the categories are totaled to obtain an estimate of indirect costs from the reported residential fires.

Each of these approaches is discussed here, with the appropriate findings from the analysis of the sample data from this study.

1. Use of a Simple Average

The most direct approach to estimating the total indirect costs incurred annually in a local area due to reported residential fires is to multiply the number of residential fires reported in the area in a given year by the average total indirect cost caused by each residential fire. Based on the data presented in Chapter II, the average value for the total indirect costs caused by all reported residential fires is approximately $440. On this basis, the total indirect

cost (TIC) incurred annually by a local area due to residential fires can be estimated as:

$$TIC = \$440 \times N$$

(N = the number of residential fires reported annually).

It must be pointed out that the average value of $440 represents the mean of a distribution of indirect costs, and that in local areas experiencing small numbers of fires the expected variation around this mean can be substantial.

2. Simple Averages for Classes of Residential Fires

As was done in designing the current research, local fire officials can attempt to reduce the variation caused by the use of a simple average value of indirect costs by breaking the residential fires into classes and using different averages for each class. We defined three general classifications in this research: Class I, where the fire caused an injury or a death; Class II, where no injury or death was reported, but property loss was estimated as being in excess of $1,000; and Class III, where no injury or death was reported, and property loss was estimated as being less than or equal to $1,000. The data indicated that the average indirect cost caused per fire varied substantially between these three classes. The estimated average indirect cost for all fires in each class are presented in Table IV.1.

Using these estimates, local officials can estimate the indirect costs incurred from reported residential fires experienced annually in their service areas as follows:

$$TIC = \$3{,}275 \times N_I + \$1{,}185 \times N_{II} + \$80 \times N_{III}$$

N_I = the number of residential fires causing injury or death,

N_{II} = the number of fires not causing injury or death, but causing property loss of more than $1,000,

N_{III} = the number of fires not causing injury or death, but causing property loss less than or equal to $1,000, and

$N_I + N_{II} + N_{III}$ = all residential fires reported in the area.

This approach is slightly more complex than the first, but it reduces the error introduced by using a single average value for indirect costs per fire.

TABLE IV.1

Average Total Indirect Cost Per Fire by Class of Fire

Class	Estimated Average Total Indirect Costs Per Fire
1. Fires Causing Injury or Death	$3,275
2. Fires Causing No Injury or Death, but Property Loss Greater Than $1,000	1,185
3. Fires Causing No Injury or Death, but Property Loss Less Than or Equal to $1,000	80

3. Simple Averages for Direct Property Loss Categories

As indicated in the previous chapter, residential fires which cause large indirect costs tend to be those which also cause large amounts of direct property losses. Thus it seems reasonable to expect that the average indirect cost will be different for fires causing different amounts of direct property loss, and the use of property loss categories may reduce the overall error introduced into the estimates. Examination of the data from the survey of households experiencing residential fires indicated that the following categories of reported direct property losses [24] seemed to be responsible for classifying the data for this purpose: $0 to $500; $501 to $5,000; $5,001 to $10,000; and $10,001 and over. Average estimated losses per category are shown in Table IV.2.

Thus, the local estimate of total indirect costs from residential fires becomes:

$$TIC = \$118 \times N_1 + \$812 \times N_2 + \$1{,}312 \times N_3 + \$3{,}353 \times N_4$$

N_1 = number of residential fires causing property loss up to \$500,

N_2 = number of residential fires causing property loss from \$501 to \$5,000,

N_3 = number of residential fires causing property loss from \$5,001 to \$10,000,

N_4 = number of residential fires causing property loss greater than \$10,000, and

$N_1 + N_2 + N_3 + N_4$ = all residential fires reported in the area.

It should be noted that the figures included in the three estimating procedures provide indirect cost estimates expressed in terms of early 1977 dollars. When local estimates are made for future years, it will be necessary to adjust the resultant figures to recognize changes in prices. Since most of the costs considered in the indirect cost estimates are also included in the computation of the Consumer Price Index, it is reasonable to use this Index as a basis of the adjustment process. Specifically, the estimated total indirect costs (TIC) should be multiplied by the ratio of the Consumer Price Index (CPI) for the year for which estimates are being made (y), to the CPI for 1977.

$$TIC_y = TIC \times \frac{CPI_y}{CPI_{1977}}$$

TABLE IV.2

Average Total Indirect Costs for Various Direct Property Loss Categories

Property Loss Category (in $)	Average Total Indirect Costs (in $)
0 to 500	118
501 to 5,000	812
5,001 to 10,000	1,312
10,001 and over	3,353

4. Summary

It is difficult to assess the accuracy of the various methods for making local estimates of total indirect costs arising from reported residential fires. It is likely, however, that the relatively more complicated procedures outlined in Sections 2 and 3 are to be preferred in that they incorporate nonlinearities into the relationship between indirect and direct costs. An important operational criterion is the data which are available, and the amount of data sorting which the local agency wishes to do. The least demanding in this regard is method one, which requires simply the number of reported residential fires which occurred in the specified time period. Most demanding is method three, which requires that the number of residential fires be broken down into four property loss categories.

[24] Reported direct property loss is used here because it is the only information available to local officials.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1980-629-972 3-1